Power optimization using energy disaggregation

Team name: Door Number - 311
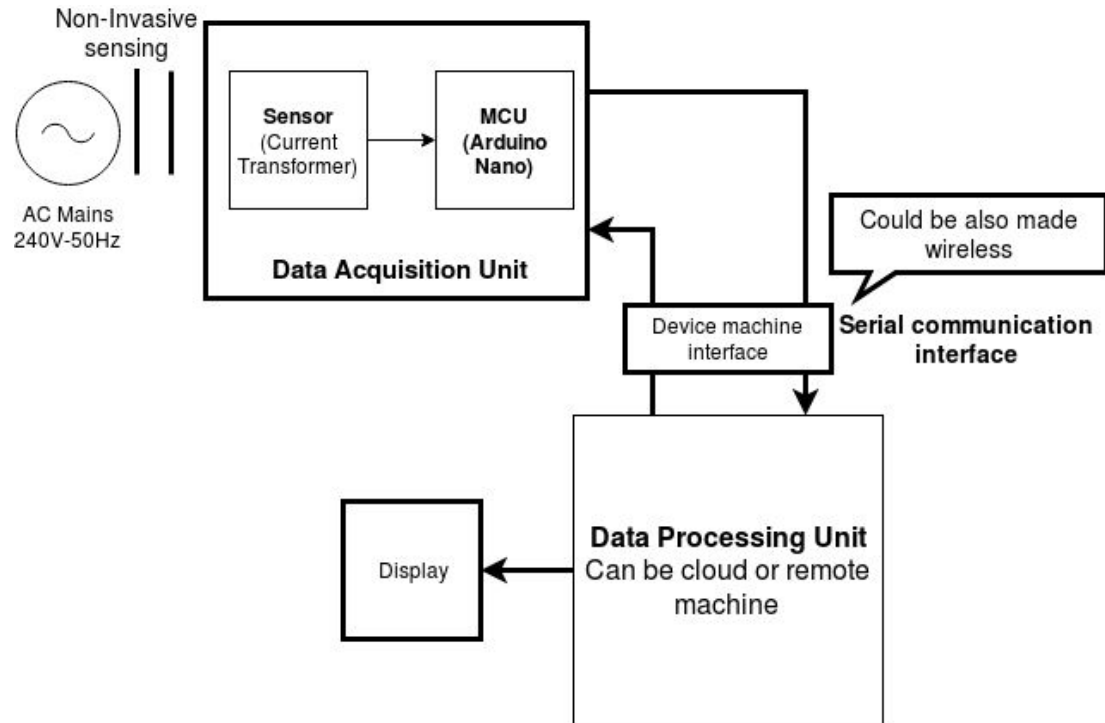
What's in the box?

- Majority of existing power optimization solutions are invasive not scalable.

- Studies have shown that energy breakdown and consumer awareness can save 15% wastage in energy all over the world*

- We are solving this problem by disaggregating energy of individual devices.

- Providing analytics as a service solution resulting in power optimization.

*Yiling Jia, Nipun Batra, Hongning Wang, and Kamin Whitehouse. 2019. A Tree-Structured Neural Network Model for Household Energy Breakdown. In Proceedings of the 2019 World Wide Web Conference (WWW '19), May 13–17, 2019, San Francisco, CA, USA. ACM, New York, NY, USA, 7 pages. https://doi.org/10.1145/3308558.3313405
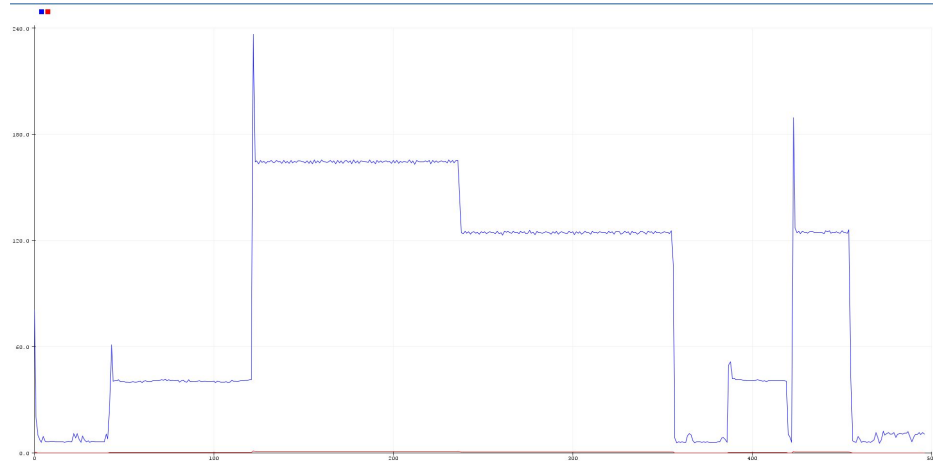
System diagram

Hackware Hardware

- Low-cost, small-form factor device which is installed in the residential buildings to capture apparent power.
- Non - Invasive solution.
- Using the module, we have acquired data for different combinations of appliances.

Data Acquisition of bulb and vacuum pump with multiple combinations.

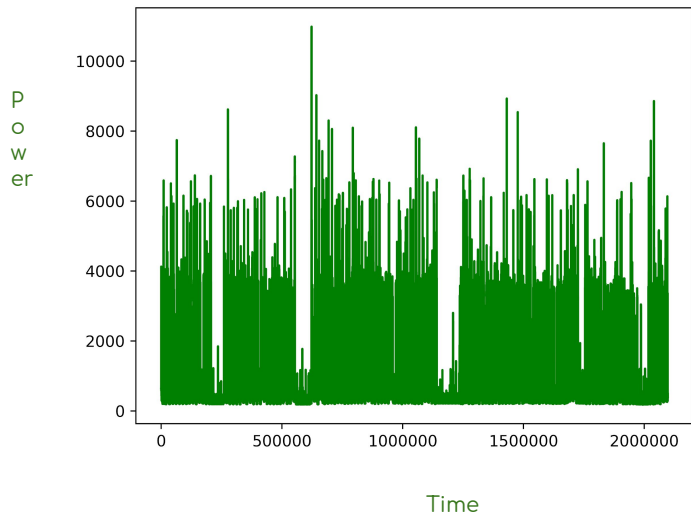# Machines can learn - Device Classification

- Classification of individual devices using LSTM neural networks.
- A simple one-layer LSTM was used to classify three devices.
- Accuracy is around 74%.
- Training data size is 4045 and test data size is 1013.
- The model size is 32KB.


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Epoch 82/100
 - 6s - loss: 0.3297 - accuracy: 0.8088 - val_loss: 0.8386 - val_accuracy: 0.7655
Epoch 83/100
 - 5s - loss: 0.3297 - accuracy: 0.8021 - val_loss: 0.9773 - val_accuracy: 0.7329
Epoch 84/100
 - 6s - loss: 0.3264 - accuracy: 0.8085 - val_loss: 0.9943 - val_accuracy: 0.7177
Epoch 85/100
 - 6s - loss: 0.3268 - accuracy: 0.8043 - val_loss: 1.0176 - val_accuracy: 0.7256
Epoch 86/100
 - 5s - loss: 0.3240 - accuracy: 0.8056 - val_loss: 1.1623 - val_accuracy: 0.6584
Epoch 87/100
 - 5s - loss: 0.3143 - accuracy: 0.8154 - val_loss: 1.1466 - val_accuracy: 0.6607
Epoch 88/100
 - 6s - loss: 0.3246 - accuracy: 0.8094 - val_loss: 1.1378 - val_accuracy: 0.6607
Epoch 89/100
 - 6s - loss: 0.3216 - accuracy: 0.8052 - val_loss: 0.9967 - val_accuracy: 0.7431
Epoch 90/100
 - 5s - loss: 0.3270 - accuracy: 0.8056 - val_loss: 1.0165 - val_accuracy: 0.6868
Epoch 91/100
 - 5s - loss: 0.3165 - accuracy: 0.8154 - val_loss: 1.2722 - val_accuracy: 0.6337
Epoch 92/100
 - 6s - loss: 0.3166 - accuracy: 0.8106 - val_loss: 1.1915 - val_accuracy: 0.6528
Epoch 93/100
 - 6s - loss: 0.3131 - accuracy: 0.8128 - val_loss: 1.4011 - val_accuracy: 0.6357
Epoch 94/100
 - 6s - loss: 0.3283 - accuracy: 0.7998 - val_loss: 1.1699 - val_accuracy: 0.6558
Epoch 95/100
 - 5s - loss: 0.3139 - accuracy: 0.8089 - val_loss: 0.9374 - val_accuracy: 0.7339
Epoch 96/100
 - 5s - loss: 0.3223 - accuracy: 0.8082 - val_loss: 1.3483 - val_accuracy: 0.6337
Epoch 97/100
 - 5s - loss: 0.3223 - accuracy: 0.8043 - val_loss: 1.1165 - val_accuracy: 0.7398
Epoch 98/100
 - 5s - loss: 0.3113 - accuracy: 0.8103 - val_loss: 1.4016 - val_accuracy: 0.6337
Epoch 99/100
 - 5s - loss: 0.3271 - accuracy: 0.8030 - val_loss: 1.0619 - val_accuracy: 0.6993
Epoch 100/100
 - 6s - loss: 0.3131 - accuracy: 0.8100 - val_loss: 1.3721 - val_accuracy: 0.6403
```

Machines can learn - Energy Disaggregation
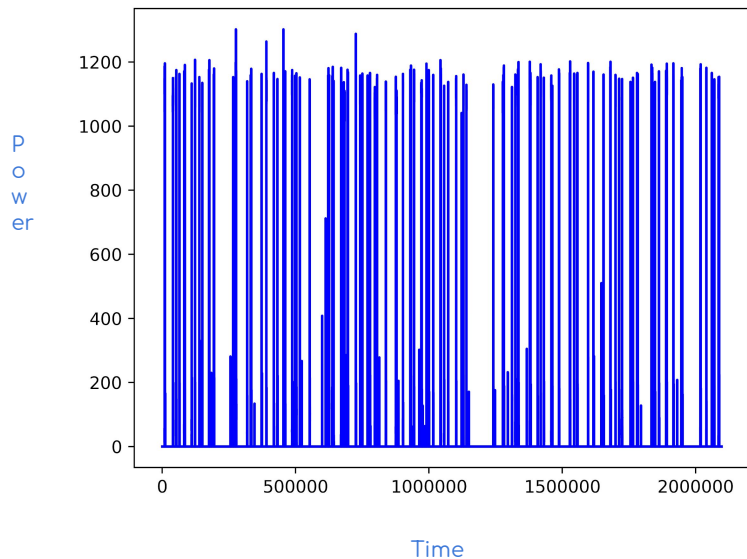
- Segregation of individual appliances on simulations.
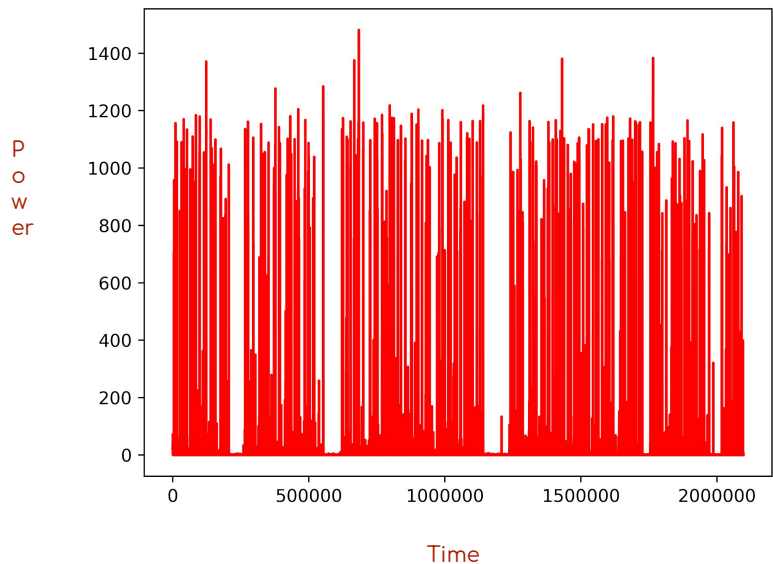
Aggregated power readings

Machines can learn - Energy Disaggregation

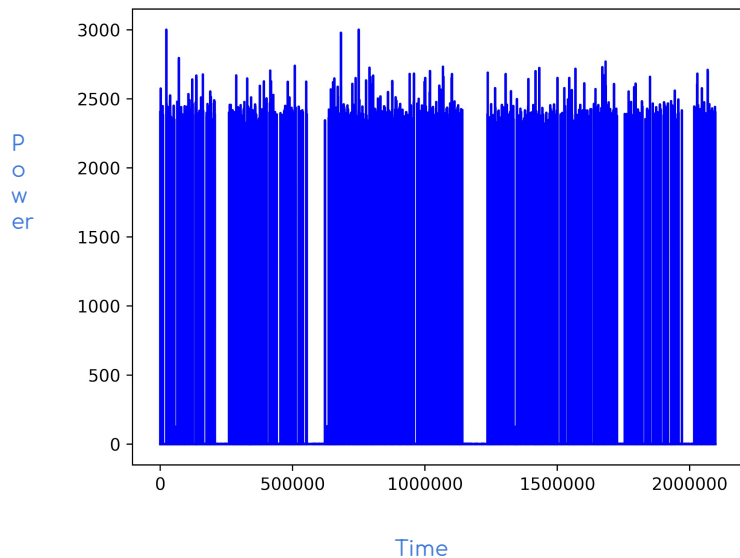- Segregation of washing machine on simulations.
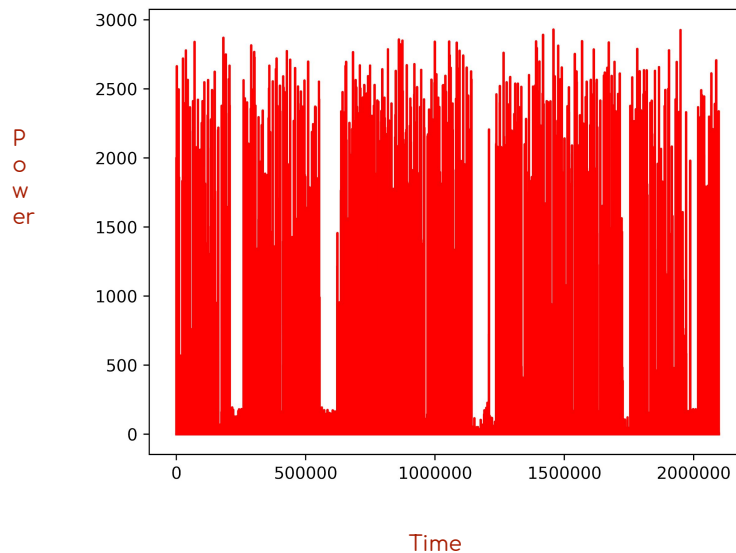
Ground truth readings

Predicted values

Machines can learn - Energy Disaggregation

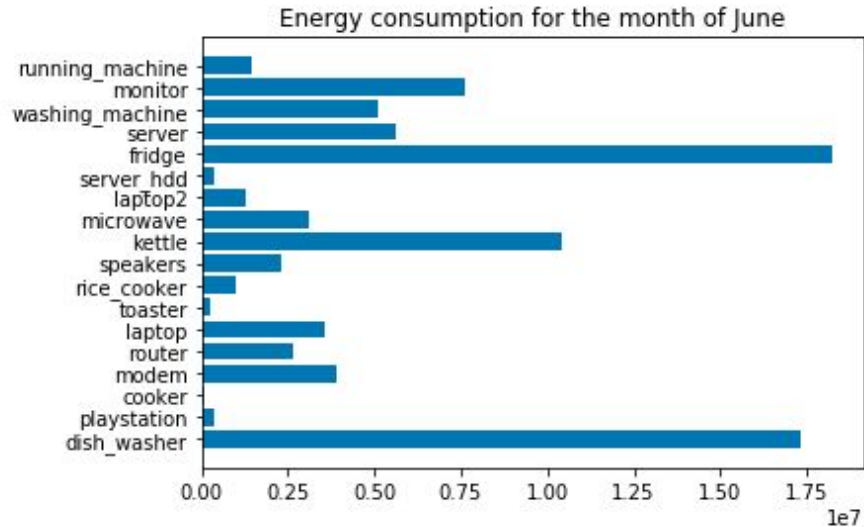- Segregation of kettle on simulations.
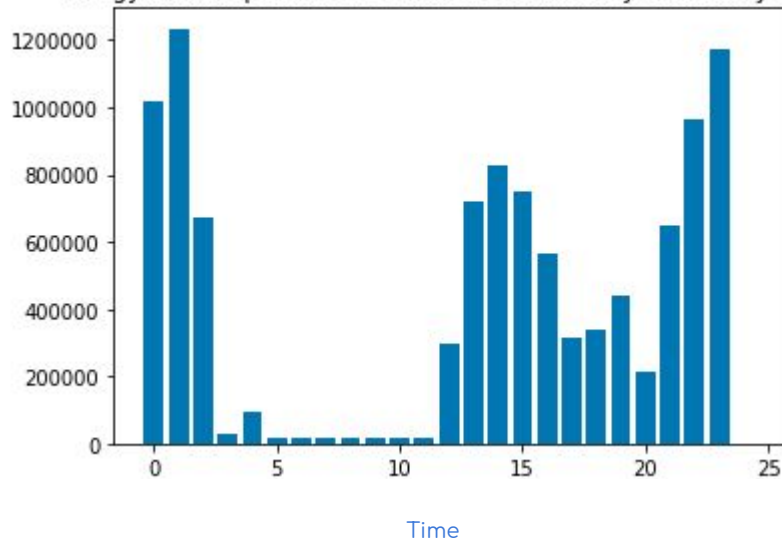
Ground truth readings

Predicted values

Machines can learn - Data Analytics

- Classified and segregated data opens door to data analytics for power optimization.
- Per device, inter-device, inter-time, inter-house analytics can be performed.
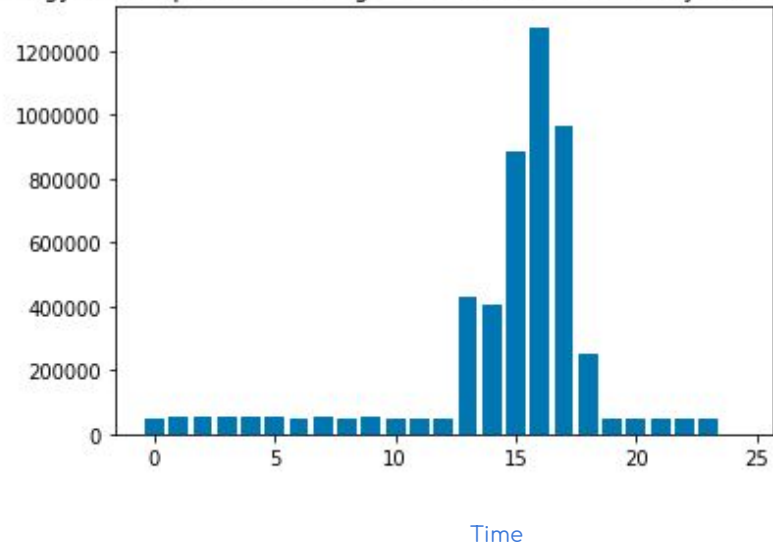

Energy consumption for the month of June

Machines can learn - Data Analytics

Energy consumption of kettle for the month of June, hourly basis
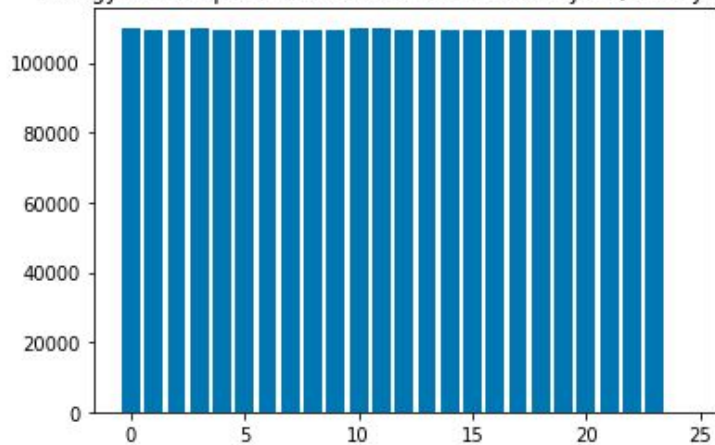

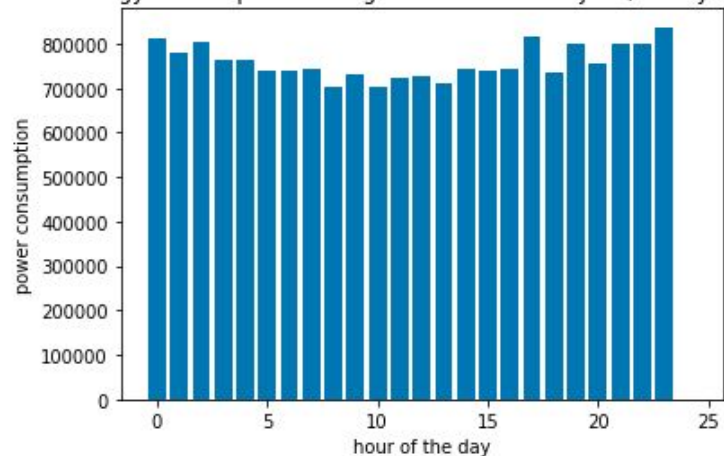Energy consumption of washing machine for the month of June, hourly basis

Machines can learn - Data Analytics

Energy consumption of router for the month of June, hourly basis

Time

Energy consumption of fridge for the month of June, hourly basis

Time

Thor is worthy, so is our solution

- No tapping of wires to measure current. It's non-invasive and safe.
- Power saving by only having a single device which can be scalable across building.
- Health monitoring of appliances. This will save the power in small scale industries, for example - faulty machines can be detected which are not working efficiently while consuming the same power as normal machines.
- Giving feedback to the consumers about the daily localized power consumption.
- This system can be doable on the edge

DEMO!

THANK YOU!